RECEIVED
CENTRAL FAX CENTER
SEP 1 5 2008

Application Serial No.: 10/582,813
Attorney Docket No: 26068-27B

Examiner: D. Nguyen
Art Unit: 2818

1. (Withdrawn) A method of exhibiting a switching behavior in the planar Hall effect (PHE) of a magnetic film that exhibits both planar Hall effect and biaxial magnetic anisotropy, which method comprises applying a sweeping magnetic field to the magnetic film such that:

at a high positive field, the magnetization is parallel to the applied magnetic field and the PHE is positive;

as the magnetic field is reduced, the magnetization gradually aligns along a first easy axis closer to the magnetic field orientation;

as the magnetic field orientation is reversed, the magnetization switches to a second easy axis, and the PHE is negative; and

as the magnetic field becomes more negative, the magnetization goes back to the first easy axis with an opposite polarity.

2. (Withdrawn) A method according to claim 1, wherein the magnetic film is a manganite thin film of the formula $R_{1-x}A_xMnO_3$, wherein R is a rare-earth metal, A is an alkaline earth metal, and x is between about 0.15 and about 0.5.

3. (Withdrawn) A method according to claim 2, wherein the rare earth metal is lanthanum.

4. (Withdrawn) A method according to claim 2, wherein the alkaline earth metal is selected from the group consisting of strontium, calcium, and barium.

5. (Withdrawn) A method according to claim 1, wherein the magnetic film is deposited on a perovskite crystal substrate.

6. (Withdrawn) A method according to claim 5, wherein the perovskite crystal substrate is strontium titanium oxide.

PAGE 4/14 * RCVD AT 9/15/2008 4:36:15 PM [Eastern Daylight Time] * SVR:USPTO-EFXRF-5/26 * DNIS:2738300 * CSID:2035752600 * DURATION (mm-ss):05-02

7. (Withdrawn) A method according to claim 6, wherein the perovskite crystal substrate is coated onto a silicon substrate.

8. (Withdrawn) A method according to claim 5, wherein the deposited film has a thickness between about 4 nm and about 100 nm.

9. (Withdrawn) A method according to claim 8, wherein the deposited film has a thickness between about 10 nm and about 50 nm.

10. (Withdrawn) A method according to claim 5, wherein the film is deposited by physical vapor deposition.

11. (Withdrawn) A method according to claim 1, wherein the Curie temperature of the film is between about 150 K and about 350 K.

12. (Original) A planar Hall effect magnetic sensor comprising:

an active area comprising a magnetic film that exhibits both planar Hall effect and biaxial magnetic anisotropy;

a first pair of conductive leads arranged on opposing sides of the active area for driving electrical current across the active area in a first direction; and

a second pair of conductive leads arranged on opposing sides of the active area in a second direction perpendicular to the first direction for measuring voltage across the active area in the second direction.

13. (Original) The magnetic sensor according to claim 12, wherein the magnetic film is epitaxially grown on a perovskite single crystal.

14. (Original) The magnetic sensor according to claim 13, wherein the magnetic film is deposited on the perovskite crystal in the shape of a cross having arm portions of approximately equal length, and the first pair of conductive leads and the second pair of

conductive leads are coated on the arm portions of the magnetic film, wherein a middle portion of the magnetic film is left uncovered by the conductive leads.

15. (Original) The magnetic sensor according to claim 14, wherein the conductive leads are copper.

16. (Original) The magnetic sensor according to claim 12, wherein the magnetic film has two easy axes that are arranged perpendicular to each other and are aligned with the first pair of conductive leads and the second pair of conductive leads.

17. (Original) The magnetic sensor according to claim 12, further comprising two conductive films deposited parallel to the first pair of conductive leads and the second pair of conductive leads and separated from the active area by one or more insulating layers, wherein said two conductive films are used to generate a magnetic field.

18. (Withdrawn) The magnetic sensor according to claim 17, wherein the two conductive films overlap each other and are positioned below the active area of the magnetic sensor, separated by the insulating layer.

19. (Withdrawn) The magnetic sensor according to claim 17, wherein the two conductive films overlap each other and are positioned above the active area of the magnetic sensor, separated by the insulating layer.

20. (Original) The magnetic sensor according to claim 17, wherein one of the conductive films is positioned above the active area of the magnetic sensor separated from the active area by a first insulating layer and the other conductive film is positioned below the active area of the magnetic sensor separated from the active area by a second insulating layer.

21. (Original) The magnetic sensor according to claim 17, wherein the conductive film is selected from the group consisting of copper, aluminum, and gold.

22. (Original) The magnetic sensor according to claim 17, wherein the one or more insulating layers are selected from the group consisting of aluminum oxides, magnesium oxides, and strontium titanite.

23. (Original) The magnetic sensor according to claim 22, wherein the one or more insulating layers are aluminum oxide.

24. (Original) The magnetic sensor according to claim 13, wherein the magnetic film is deposited on the crystal by physical vapor deposition.

25. (Original) The magnetic sensor according to claim 12, wherein the deposited film has a thickness between about 4 nm and about 100 nm.

26. (Original) The magnetic sensor according to claim 25, wherein the deposited film has a thickness between about 10 nm and about 50 nm.

27. (Original) The magnetic sensor according to claim 12, wherein the magnetic film is a manganite thin film of the formula $R_{1-x}A_xMnO_3$, wherein R is a rare-earth metal, A is an alkaline earth metal, and x is between about 0.15 and about 0.5.

28. (Original) The magnetic sensor according to claim 27, wherein the rare earth metal is lanthanum.

29. (Original) The magnetic sensor according to claim 27, wherein the alkaline earth metal is selected from the group consisting of strontium, calcium, and barium.

30. (Original) A magnetic bit cell for use in a planar Hall effect magnetoresistive random access memory (MRAM) device, the magnetic bit cell comprising:

an active area comprising a magnetic film that exhibits both planar Hall effect and biaxial magnetic anisotropy;

a first pair of conductive leads arranged on opposing sides of the active area for driving electrical current across the active area in a first direction; and

a second pair of conductive leads arranged on opposing sides of the active area in a second direction perpendicular to the first direction for measuring voltage across the active area in the second direction.

31. (Original) The magnetic bit cell according to claim 21, wherein the magnetic film is epitaxially grown on a perovskite single crystal.

32. (Original) The magnetic bit cell according to claim 31, wherein the magnetic film is deposited on the perovskite crystal in the shape of a cross having arm portions of approximately equal length, and the first pair of conductive leads and the second pair of conductive leads are coated on the arm portions of the magnetic film, wherein a middle portion of the magnetic film is left uncovered by the conductive leads.

33. (Original) The magnetic bit cell according to claim 30, wherein the conductive leads are copper.

34. (Original) The magnetic bit cell according to claim 31, wherein the magnetic film is epitaxially grown on the single crystal so that easy axes of the thin film are perpendicular to each other and at a 45-degree angle relative to the direction of the current.

35. (Original) The magnetic bit cell according to claim 30, further comprising a first write bit line and a second write bit line electrically isolated from the magnetic bit cell by an insulating layer.

36. (Original) The magnetic bit cell according to claim 35, wherein the first write bit line and the second write bit line are arranged perpendicular to each other.

37. (Withdrawn) The magnetic bit cell according to claim 36, wherein the first write bit line and the second write bit line overlap each other and are positioned below the active area of the magnetic bit cell, separated by the insulating layer.

38. (Withdrawn) The magnetic bit cell according to claim 36, wherein the first write bit line and the second write bit line overlap each other and are positioned above the active area of the magnetic bit cell, separated by the insulating layer.

39. (Original) The magnetic bit cell according to claim 36, wherein one of the write bit lines is positioned above the active area of the magnetic bit cell separated from the active area by a first insulating layer and the other write bit line is positioned below the active area of the magnetic bit cell separated from the active area by a second insulating layer.

40. (Original) The magnetic bit cell according to claim 35, wherein the insulating layer is an aluminum oxide or strontium titanite.

41. (Original) The magnetic bit cell according to claim 35, wherein the first write bit line and the second write bit line comprise a conductive film through which current can be passed.

42. (Original) The magnetic bit cell according to claim 41, wherein a combination of current in the first write bit line and the second write bit line generates a field that flips the magnetization between the two easy axes of the magnetic bit cell.

43. (Original) The magnetic bit cell according to claim 31, wherein the magnetic film is deposited on the crystal by physical vapor deposition.

44. (Original) The magnetic bit cell according to claim 43, wherein the deposited film has a thickness between about 4 nm and about 100 nm.

45. (Original) The magnetic bit cell according to claim 44, wherein the deposited film has a thickness between about 10 nm and about 50 nm.

46. (Original) The magnetic bit cell according to claim 30, wherein the magnetic film is a manganite thin film of the formula $R_{1-x}A_xMnO_3$, wherein R is a rare-earth metal, A is an alkaline earth metal, and x is between about 0.15 and about 0.5.

47. (Original) The magnetic bit cell according to claim 46, wherein the rare earth metal is lanthanum.

48. (Original) The magnetic bit cell according to claim 46, wherein the alkaline earth metal is selected from the group consisting of strontium, calcium, and barium.

49. (Withdrawn) A method of operating a magnetoresistive random access memory (MRAM) device comprising:

a) providing a plurality of magnetic bit cells, wherein each of the plurality of magnetic bit cells comprises:

an active area comprising a magnetic film that exhibits both planar Hall effect and biaxial magnetic anisotropy;

a first pair of leads arranged on opposing sides of the active area for driving electrical current across the active area in a first direction;

a second pair of leads arranged on opposing sides of the active area in a second direction that is perpendicular to the first direction for measuring voltage across the active area in the second direction; and

a first write bit line and a second write bit line electrically isolated from the active area of the magnetic bit cell by an insulating layer;

wherein the magnetic film has two easy axes that are arranged perpendicular to each other and at a 45-degree angle relative to the direction of the current; and

b) performing a read operation on the bit cell by driving electrical current through the first pair of leads in the first direction across the active area and measuring the voltage across the active area with the second set of leads in the second direction.

50. (Withdrawn) The method according to claim 49, wherein a combination of currents in the two write bit lines generates a magnetic field which flips the magnetization between the two easy axes, wherein the sign of the voltage indicates along which of the two easy axes the magnetization in the bit cell resides.

51. (Withdrawn) The method according to claim 49, wherein the magnetic film is a manganite thin film of the formula $R_{1-x}A_xMnO_3$, wherein R is a rare-earth metal, A is an alkaline earth metal, and x is between about 0.15 and about 0.5.

52. (Withdrawn) The method according to claim 51, wherein the rare earth metal is lanthanum.

53. (Withdrawn) The method according to claim 51, wherein the alkaline earth metal is selected from the group consisting of strontium, calcium, and barium.

54. (Withdrawn) The method according to claim 49, wherein the magnetic film is epitaxially grown on a perovskite single crystal.

55. (Withdrawn) A method of using a planar Hall effect magnetic sensor device, the method comprising the steps of:

a) providing a magnetic sensor device comprising:

i) an active area comprising a magnetic film that exhibits both planar Hall effect and biaxial magnetic anisotropy;

ii) a first pair of conductive leads arranged on opposing sides of the active area for driving electrical current across the active area in a first direction;

iii) a second pair of conductive leads arranged on opposing sides of the active area in a second direction perpendicular to the first direction for measuring voltage across the active area in the second direction; and

iv) two conductive films deposited parallel to the first pair of conductive leads and the second pair of conductive leads, said two conductive films being separated from the active area by an insulating layer, wherein said two conductive films are used to generate a magnetic field;

wherein the magnetic film has two easy axes that are arranged perpendicular to each other, with one of the easy axes arranged parallel to the direction of the current;

b) presetting the magnetization in the magnetic film in the first direction with a pulse of current,

wherein the magnetic sensor device is sensitized to any magnetic field applied in the second direction, resulting in a change in voltage measured in the second direction.

56. (Withdrawn) The method according to claim 55, wherein after the magnetization is preset in the first direction, an alternating current for generating alternating magnetic field is applied in the second direction, wherein the effect of an external magnetic field may be determined by monitoring its effect on the alternating voltage response.